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Control of charged domain wall parameters in lithium niobate single crystals using various liquid and solid electrodes

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The domain walls inclined to the polar axis in uniaxial ferroelectrics possess the bound surface charge due to discontinuity of normal component of spontaneous polarization. The charged domain walls (CDW) have attracted great scientific attention during last ten years, due to strong difference of their properties from that of the bulk materials. In particular, it was shown that conductivity of the charged domain walls in lithium niobate (LN) single crystal is 13 orders of magnitude higher than that of the single-domain crystal [1]. The possibilities to create, displace and erase of unit-cell-thick CDW by the external electric field are the appealing prospects for further applications in resistive data storage devices and reconfigurable electronics.

Naturally, the domains in uniaxial ferroelectrics represent themselves right-angle prisms, and the cross-sections of the domains by Z+ and Z- polar surfaces are identical. Domain walls tend to be neutral to reduce electrostatic energy of the system. However, this rule can be violated under certain conditions. Here we show that one of the options to control the domain wall inclination angle is the proper selection of electrode material used for field application during polarization reversal.

We present the experimental study of the CDW formation during polarization reversal in the magnesium oxide doped LN single crystals (MgO:LN). It was shown that material of the electrode at negative polar surface (Z-) is crucial. Conductive charged domain walls could be produced using solid (metal or semiconductor) electrode, whereas liquid electrolyte electrodes lead to growth of neutral walls. The domain walls were visualized in the crystal bulk using scanning Cherenkov SHG microscopy [2]. The time dependence of the conductivity of charged domain walls was measured. Controllable electrodeposition of silver on the conductive domain walls was demonstrated.

The research was funded by RFBR (grant № 18-32-00641). The equipment of the Ural Center for Shared Use “Modern nanotechnology” Ural Federal University was used.

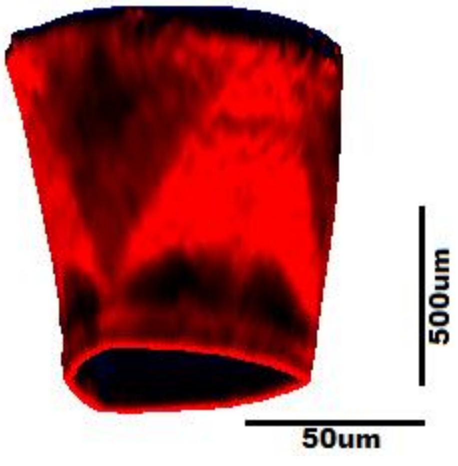

Figure 1. Charged domain wall in MgOLN crystal obtained by 3D reconstruction of Cherenkov SHG microscopy data. Saturation of the red colour is proportional to the wall local inclination from the polar direction.

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